Investigating the Relationship Between Teacher Professional Vision and Classroom Practices: A Case of Misalignment

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This paper investigates the relationship between teachers' professional vision and their classroom practices. In particular, the study finds that teachers with similar professional vision can have different classroom practices related to noticing and responding to student thinking. Data is drawn from a study in which teachers reflected on video online as well as collected video from their own classrooms. Analysis revealed two teachers with similar attention to student mathematical thinking when watching classroom videos. However, these teachers recalled noticing interesting moments of student thinking, made space for student thinking to emerge, and probed students' underlying understandings with different frequency in their classrooms.

Keywords: Classroom Discourse; Teacher Knowledge; Teacher Education-Inservice/Professional Development, High School Education

Researchers have proposed that a key component of teaching is the ability to notice and interpret what happens in the classroom. Classrooms are complex environments with many events unfolding simultaneously, thus interpreting important features of classrooms requires skill. This ability has been called teachers' *professional vision* (Goodwin, 1994), which is described as teachers' ability to "make sense of what is happening in their classrooms" (Sherin, 2007, p. 384). From the perspective of mathematics education reform, developing teachers' in-the-moment professional vision with respect to student thinking is necessary in order to adopt a responsive or student-centered approach to teaching mathematics.

New methodologies for investigating teacher professional vision have emerged, which have allowed researchers to investigate teachers' in-the-moment noticing (Colestock & Russ, 2010; Sherin & Sherin, 2010). Previously, teacher professional vision was primarily measured through reflection on video, which is likely to be different than teachers' in-the-moment noticing (Sherin, Jacobs, & Philipp, 2011). To distinguish between these two types of professional vision, I will call noticing that occurs while teaching *online professional vision* and noticing that does not occur while teaching (e.g. reflection on video) *offline professional vision*. We might expect these two types of professional vision to differ because the online context includes the "blooming buzzing confusion of sensory data" found in the classroom in addition to requiring teachers to complete many other cognitive tasks at the same time (Sherin & Star, 2011, p. 69).

A variety of research studies have shown that developing teacher professional vision can impact teachers' classroom practice (Frederiksen, Sipusic, Sherin, & Wolfe, 1998; Sherin & Han, 2004; Sherin & van Es, 2005; van Es & Sherin 2010). These studies hypothesize that tuning teachers' offline professional vision to notice students' mathematical ideas increases their focus on attending to and responding to student ideas while teaching. However, these studies have used video as the material for supporting the development of professional vision. Therefore, they claim that development of offline professional vision can impact teachers' classroom practice, which seems to indicate that offline professional vision is closely related to teaching practices. In this paper, I will investigate a case of two teachers with similar offline professional vision but different online professional vision and classroom practices with respect to noticing and

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responding to student thinking. I will begin by describing the participants and data sources I will draw upon, and explain the methods used to analyze this data. I will then describe the findings related teachers' offline professional vision, online professional vision, and classroom practices. Finally, I will discuss several explanations for the findings and implications for research on professional vision and teacher education designed to develop teacher professional vision in ways that impact classroom practices.

Methods

Participants and Data Sources

The data used in this paper come from an investigation of teachers' efforts to collect video clips that can support productive video club discussions about student thinking (Sherin, Linsenmeier, & van Es, 2009) . The participants were four high school mathematics teachers from a suburban Midwestern school. All names referenced in this paper are pseudonyms. Each teacher chose one of his or her classes to participate in the study. The teachers attended five 40-minute meetings over the course of 10 weeks. In the meetings, teachers participated in video clubs and discussed what types of clips can support productive video clubs. After each meeting, the teachers collected two to three video clips from their classrooms that they thought would support productive video club discussions and explained their reasons for selecting the clips as well as moments they would suggest discussing in a video club.

To see if participants' judgment of the likelihood of video clips to support productive video clubs was influenced by the study, participants completed an online task where they rated video clips before and after all of the meetings. Participants watched four different 4- to 6-minute video clips of high school mathematics classrooms. The videos were chosen to include a variety of likelihoods to support discussions about student mathematical thinking and different classroom structures (e.g. whole-class discussion, student presentations, small group work). For each video, participants were asked to rate the likelihood that the clip would "support a fruitful discussion of student mathematical thinking" on a four-point scale of very unlikely, somewhat unlikely, somewhat likely, very likely. They were also asked to explain their rating using at least three sentences and describe two moments or topics from the video that they would recommend discussing during a video club about student mathematical thinking.

Participants also completed an online task where they indicated (or "tagged") moments of interesting student mathematical thinking at the beginning and end of the study to see if participants' noticing of student mathematical thinking was influenced by the study. Participants watched two 4- to 6- minute video clips of high school mathematics classrooms. The video were selected because they provided several moments of interesting mathematical thinking expressed by students with varying degrees of clarity. For each video, participants were asked to tag moments of interesting student mathematical thinking while watching the video and describe the student thinking they tagged. If they tagged more than three moments, participants were asked to pick the three most interesting moments and explain why they picked those moments.

The participants were interviewed over the phone shortly after each time they collected video from their classrooms and before they had a chance to review the video. These interviews were designed to capture the thinking process teachers went through in capturing clips. These interviews focused on what participants intended to capture, whether they thought they captured what they intended to capture, and any moments they wish they would have captured. Finally, participants' classrooms were observed two times during the beginning of the study and one or two times when they were collecting video clips after the final two meetings. The teachers suggested days that would be good to observe their classrooms. Each classroom was videotaped

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using two cameras. One camera focused on the whole class, including the chalkboard or screen if used. The second camera captured the work of one group in the class, often chosen by asking the teacher what group would be good to capture. If the students were not working in groups, the second camera was focused on the whole class. The teachers were asked if the lessons observed were typical, and the teachers indicated that the lessons were typical for them with the exception of one lesson. One of Sam's lessons was longer than usual, which caused him to add an activity to the beginning of the lesson, which he would normally not have students complete. The findings are similar qualitatively with or without this activity. In fact, the findings are stronger when excluding this atypical activity.

Analysis of Professional Vision

To analyze professional vision, both administrations of online video tasks were examined as well as comments teachers made during interviews about moments of student thinking they noticed in their own classrooms. In the online tasks common moments teachers mentioned or tagged at the beginning and end of the study were treated as one moment.

I adopted the framework used by Sherin and van Es (2009), who define professional vision of teachers in terms of two aspects: *selective attention* and *knowledge-based reasoning*. Selective attention refers to what teachers pay attention to. In my analysis of selective attention in the clip-rating task, I coded the explanation of the clip rating and productive moments or topics to discuss during a video club in terms of actor and topic codes used by Sherin and van Es (2009) with the addition of the topic code *mathematics* for topics that are purely mathematical that do not explicitly reference student thinking found in the video. These codes are summarized in Table 1. Additionally, I coded for the specific moments of the clip or topics that were referenced.

The analysis of the interesting moments tagged by teachers followed the procedure used in Walkoe (2013), which focuses on the selective attention of teachers. To find instances when teachers tagged the same moment in the video, tags within a 10 second range were identified. Only tags that were identified as one of the three most interesting were used. The moment that the teachers were referencing was determined by their description of the student thinking they tagged. Instances when teachers referenced the same moment but different aspects of that moment were treated as different moments. Eight different moments were identified in one video and 15 different moments were identified in the other video. To look for similarity in selective attention, the proportion of moments identified in common among all possible pairs of teachers was calculated by dividing the number of common moments for both teachers by the sum of the number of coded moments from each teacher. This proportion can range from 0 (no common moments) to .5 (all common moments).

Knowledge-based reasoning refers to how teachers interpret what they attend to. Sherin and van Es (2009) restrict their analysis of reasoning related to student thinking, and analyzed these data based on two dimensions: stance and strategy used to explore student math thinking. This analysis of knowledge-based reasoning deviated from that used in Sherin and van Es (2009) primarily because the interpretation of the video was done in a different context. In this data, teachers were asked to rate the clip in terms of how likely it would be to support discussions of students' mathematical thinking, which corresponds with their interpretation of the clip. After collapsing the clip rating scale into two categories (supportive and unsupportive), teachers that rated clips similarly were seen as having similar knowledge-based reasoning. Additionally, I coded the productive topics responses in terms of the strategy used to explore student math thinking coding scheme that was used in Sherin and van Es (2009). Only instances that were coded as *student math thinking* for topic were included in this analysis because the coding

scheme did not apply to the other topics. These codes are summarized in Table 1. This provides another measure of teachers' interpretation of the clips.

Table 1: Summary of Coding Categories for Professional Vision

Selective Attention	*Knowledge-based Reasoning*
Actor	*Strategy*
Student	Restate student ideas
Teacher	Interpret student ideas
Topic	Generalize student ideas
Student math thinking	
Management	
Climate	
Pedagogy	
Mathematics	

The interviews completed with teachers were analyzed to find references to selective attention that happened while teaching. Interview transcripts were coded using a top-down approach to identify instances when teachers recalled in-the-moment noticing of moments or episodes that, if captured on video, would support video clubs about student thinking. Because interpretations of these moments were not elicited during interviews, these instances were analyzed only in terms of selective attention.

The online video tasks will be used as a measure of offline professional vision because they are not completed while teaching. The interview comments will be used as a measure of online professional vision because they reference noticing completed while teaching.

Analysis of Classroom Practice

To analyze classroom practice related to noticing student thinking, I adapted the analysis used in van Es and Sherin (2010). Only data from the first two observations were used because the final observations were completed when teachers were capturing video so they would be less likely to reflect typical teaching practice. The video was segmented into 2-minutes sections. Using the same categories in van Es and Sherin (2010), each segment was coded for (a) making space for student thinking, and (b) probing student thinking. A summary of the sub-codes for each category is given in Table 2.

Table 2: Summary of Coding Categories for Classroom Practices

Making space for student thinking	*Probing student thinking*
Publicly recognizing unsolicited student ideas	Asking for explanations
Providing extended opportunities for student thinking	Probing explanations
Eliciting multiple methods or solutions from students	

In addition to looking at instances of classroom practices associated with noticing student thinking, the extent to which there were sections of video that would support video club discussions was also investigated. Segments of video that would be likely to support productive video club discussions about student thinking (as determined by Sherin et al., 2009) at least two minutes in length were identified. Segments about a similar topic that were longer than six minutes were split into two different segments because video clips used in video clubs are normally 4-6 minutes in length.

Findings

The findings are separated into sections about offline professional vision, online professional vision and classroom practices with respect to noticing and responding to student thinking.

Offline Professional Vision

Two teachers were found to have similar offline selective attention and knowledge-based reasoning in my sample, Sam and Matt. For both teachers, almost all comments made about the videos had students as the actor and their mathematical thinking as the topic. Sam and Matt also mentioned similar topics and strategies when asked what to discuss about the video, with both teachers focusing on student mathematical thinking. Sam had 11 topic instances about student math thinking, two about mathematics, and one about pedagogy. Sam had all 15 topic instances about student math thinking. Additionally, in three of the four clips, the teachers mentioned similar aspects of the video in their explanations. Given the complexity of classrooms and video of classrooms, attending to similar elements of the video is strong evidence that the teachers had similar selective attention. The clip that they did not notice similar elements in was also rated (i.e. interpreted) differently.

This result is unsurprising because the participants were asked to rate the likelihood that the clips would support discussion of student mathematical thinking. However, the other two teachers' selective attention was not as similar. Gwen's responses show much more attention to the teacher and pedagogy, particularly when describing productive topics to discuss in a video club of student thinking. Harry's responses are more similar to those of Sam and Matt, but he referenced fewer aspects of student thinking in his explanations for clip ratings and he paid more attention to the teacher and pedagogy when describing productive topics. Therefore, Sam and Matt seem to be the teachers with the most similar selective attention among the four. This is confirmed when examining the findings from the online tagging tool as well, which is discussed below.

Table 3: Frequency of Actor and Topic Codes in Clip Rating Task

	Actor		Topic			
	Student	Teacher	Student math thinking	Pedagogy	Mathematics	Climate
Explanations						
Sam	22	0	21	0	0	1
Matt	20	2	20	2	0	0
Gwen	13	1	11	3	0	0
Harry	16	1	14	0	0	0
Productive Topics						
Sam	14	0	11	1	2	0
Matt	15	0	15	0	0	0
Gwen	11	16	6	21	0	0
Harry	13	3	13	3	0	0

The analysis of the video tagging task supports the conclusions made previously that Sam and Matt have the most similar professional vision. They had the highest proportion of moments that they both noticed. Table 4 shows how Sam and Matt had over half of the moments they noticed in common, while all other pairings of teachers had less than half of the moments they noticed in common.

Table 4: Proportion of Common Moments Identified in the Video Tagging Task

	Sam	Matt	Gwen
Matt	.28 (5/18)		
Gwen	.21 (4/19)	.21 (4/19)	
Harry	.12 (2/17)	.18 (3/17)	.17 (3/18)

In my analysis of knowledge-based reasoning, I will focus only on the two teachers previously identified as having similar selective attention. Sam and Matt also had similar knowledge-based reasoning. They rated three of the four clips similarly, including identical initial ratings for two of the clips. The strategies used to explore student thinking that were used in the productive topics was predominantly restating student ideas for both teachers. Matt seems to use the interpreting student ideas strategy more than Sam, using it six times compared to two. These findings are summarized in Table 5.

Table 5: Frequency of Codes for Strategy Used to Explore Student Thinking

	Restate student ideas	Interpret student ideas	Generalize student ideas
Sam	9	2	1
Matt	8	6	0

From these analyses, we see that not only are the two teachers attending to similar events in the videos, but they are interpreting those events similarly as well.

Online Professional Vision

Although Sam and Matt had similar offline professional vision, the two teachers recalled having different online selective attention of student thinking in their classrooms. In the five interviews conducted with Sam, he only mentioned noticing student thinking that would support video club discussions one time. He remarked in one of the interviews that "I'm sure there were moments where students had amazing discussions, I just don't know when they were," which indicates that he realized that he was not noticing the moments he was trying to capture while they happened. For the one instance that he recalled noticing, his comments were more general instead of describing specific ideas that he noticed the students had. He said, "there's another group that I felt had amazing conversations...and there were a bunch of these sort of aha moments that the kids had where I wish that I had been filming those…I-I can't think of a specific thing…" In this example, Sam provided general descriptions of the moment he remembered, like "amazing conversations" and "aha moments", but says he is unable to remember the specific things that students were doing as evidence for these descriptions. This interview was completed a day after he videotaped, which could have impacted his ability to remember the specific student ideas he noticed while teaching.

In contrast, in all five of the interviews Matt recalled noticing student groups that he visited having good discussions and when interesting whole class discussions happened. He could regularly remember specific things students said and why they were interesting. For example, he remembered an interesting idea students had about finding the number of ways that the letters in a word can be rearranged when he recalled,

> The class came to a very odd understanding of what it meant for order to matter…they were saying, what the problem says, that we can switch the letter of the orders around. Therefore …the order of the letters must not be important.

In this example, we see that he could remember the specific way the students thought that he found interesting rather than just recalling that something interesting happened. Although four of the five interviews were conducted the same day he videotaped his classroom, some of the specific ideas he recalled were from previous lessons that he wished he had videotaped.

Classroom Practices

Although both teachers had similar structures to their class, their practices with respect to noticing and responding to student ideas was very different. Both teachers had students work in small groups on problems and then discuss the problems as a whole class. However, both the small group work and the large-group discussions provided different opportunities for making space for student thinking and for probing student thinking.

Both teachers' segments reflected the teachers making space for student thinking, although Matt used these practices more frequently. There are larger differences in their practices related to probing student thinking. None of Sam's segments show him asking for explanations or probing student explanations. In contrast, Matt's segments have him asking for explanations, and probing student explanations about as frequently as his practices related to making space for student thinking. These findings are summarized in Table 6. If we normalize based on the number of minutes of instruction, these differences increase because Sam was observed for 110 instructional minutes while Matt was observed for 94 instructional minutes.

Table 6: Frequency of Segments of Noticing-Related Classroom Practices

	Making Space for Student Thinking			Probing Student Thinking	
	Publicly recognizing unsolicited student ideas	Providing extended opportunities for student thinking	Eliciting multiple methods or solutions	Asking for explanations	Probing explanations
Sam	4	2	3	0	0
Matt	6	4	6	4	7

Sam's classroom also had fewer segments that would support productive discussions than Matt. Sam's observations contained 5 segments, while Matt's observations contained 8 segments. If we normalize based on the number of minutes of instruction, Sam's observations contained .45 segments per 10 minutes of instruction, while Matt's observations contained .85 segments per 10 minutes of instruction, almost twice as many. Additionally four of Sam's five segments happened during an activity he would not have given normally (which he gave due to extra instructional time), so the difference in the frequency of segments may actually be underestimated by the observations.

It may be that these instructional practices related to probing student explanations are linked with the frequency with which clips that support video club discussions happen. We might imagine that probing student thinking makes it more likely that student thinking will be visible, a key aspect of clips that support video club discussions.

Discussion

In this paper I have shown that while two teachers have similar offline professional vision, their instructional practices related to attending to student thinking differ remarkably. Teacher professional vision is primarily developed through offline activities, so these results may indicate that online activities designed to develop professional vision may be necessary in order to impact classroom practices of some teachers. However, a similar misalignment between online professional vision and classroom practices may exist for teachers.

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There may be several reasons why the difference in offline professional vision and classroom practices were observed in this study. First, Sam is a first-year teacher, while Matt has more than five years of teaching experience. Sam may have developed sophisticated offline professional vision, but it might take more experience teaching in order to develop instructional practices that are similarly sophisticated. Many of the instructional practices that Sam did show related to making space for student thinking could be easily planned for in advance of instruction, while the practices related to probing student thinking require action in-the-moment and cannot be as easily planned for.

The findings also indicate that offline and online professional vision are potentially different for teachers. Sam's online professional vision was not as developed as his offline professional vision. As a beginning teacher there may be more non-routine cognitive work required, so they may not have the necessary cognitive resources available to devote to noticing. Additionally, it may require significant practice or experience in order to develop online professional vision. While I have hypothesized that the measurement of teacher professional in this study differed between offline and online, there are other ways of interpreting this difference. In particular, the differences in the measures of professional vision could be described as professional vision of other teachers' classroom versus professional vision of teachers' own classrooms. Future studies could investigate whether teacher professional vision when watching videos differed depending on whether the video was from another teachers' classroom or a teacher's own classroom.

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